Stabilization of a lean premixed flame by nanosecond discharges

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The energy production worldwide relies mainly on combustion and cannot be substituted by emission free sources in many industrial processes. Combustion is responsible for pollutant emissions that can be mitigate when burning lean premixed fuel-oxidizer mixtures. This type of flames is nevertheless very instable and subject to blowout, therefore not satisfactory for practical applications.
Plasmas have demonstrated very promising results to stabilize lean flames [1-3]. Nanosecond repetitively pulsed discharges [4-5] enable relevant choice of reduced electric field to heat the gas and brings a chemical selectivity to promote the production of radicals to increase the flame speed and thus stabilize the combustion [6-7].
Our goal is to characterize experimentally the thermal and chemical plasma effects to develop a predictive model suitable for combustion simulations without adding prohibitive computational costs.
Experiments are carried out with a bluff-body burner. The methane-air flame is stabilized by nanosecond discharges of 6 kV applied at 20 kHz [8], the deposited energy is equal to 1.8 mJ per discharge. Temperature and species are measured by optical emission spectroscopy and laser induced fluorescence.
Numerical simulations of the experimental configuration are performed using a model previously developed [9-10]. Temperature and flame shape are well reproduced as shown in Fig. 1 and 2.

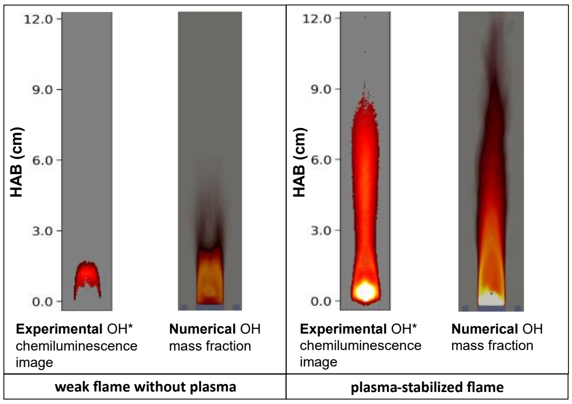

Figure 1 *Comparison of numerical and experimental visualizations of the flame shape with and without plasma*

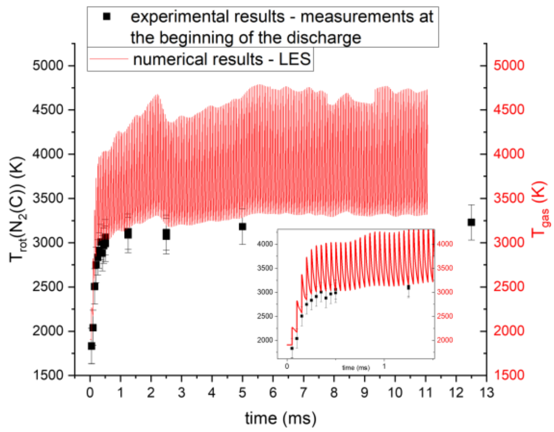

Figure 2 *Comparison of numerical and experimental temperature evolutions of a lean flame stabilized by nanosecond discharges*

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